With regard to the objections to the specification, it is believed that the above specification changes overcome these objections.

Claims 1-2, 4-5, 7-8, 10 and 18 have been rejected under 35 U.S.C. § 102(a) as being anticipated by Johnson et al. (U.S. Patent 6,216,064). Claim 9 has been rejected under 35 U.S.C. § 103(a) as being unpatentable over Johnson et al. in view of Burgett et al. (US Patent 6,522,298). Claims 11-15 have been rejected under 35 U.S.C. § 103 as being unpatentable over Johnson et al. in view of Tao et al. (U.S. Patent 5,796,609). Claims 35 and 36 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over Johnson et al. in view of Burgett et al. Applicant respectfully traverses these rejections for reasons set forth hereafter.

Initially, the examiner is thanked for indicating claims 3, 6, 19, and 20 to be allowable if rewritten in independent form. Accordingly, claims 3 and 6 have been rewritten in such independent form. The examiner is also thanked for indicating claims 16-17, and 21-34, to be allowable. With regard to such allowable and allowed claims, Applicant does not agree with the reasons for allowance. Essentially, the reasons for allowance recite each and every limitation expressly recited in the allowed claims 3, 6, 16, 19, 20, and 21. Applicants do not agree that each and every limitation recited in the reasons for allowance is necessarily required to define patentable subject matter. Accordingly, Applicant reserves the right to pursue separate and broader protection in continuation applications, divisional applications, reissue applications, and the like. Also, regarding claims 17 and 22-34, Applicant believes that such claims separately define additional limitations that are allowable independent of any base claims from which they depend.

Turning to the rejection of claim 1, based on Johnson, it is submitted that Johnson does not teach or suggest the claimed navigation device since Johnson lacks, among other things, the claimed processor and filter. Claim 1 recites a navigation device, including a barometric altimeter, a processor, and a filter. The processor provides GPS elevation readings, based on GPS measurements, and calculates differences between barometric elevation readings and GPS

elevation readings. The claimed filter filters the differences calculated by the processor to produce a barometer correction quantity. The filter is adjustable between a short-time constant and a long-time constant, based on a time-lapsed since a predetermined event. The processor corrects the barometric elevation readings, based on the barometer correction quantity.

In contrast, Johnson describes a method and apparatus for determining altitudes and an estimated error of the altitude. In Johnson's system, no processor calculates differences between the barometric elevation readings and the GPS elevation readings. Nor does any filter exist in Johnson's system which filters such differences to produce a barometer correction quantity. Nor, is any filter in Johnson's system adjustable between a short-time constant and a long-time constant, based on time-lapsed since a predetermined event. After closely reviewing the cited teachings of Johnson, nowhere has it been found where Johnson's system calculates the claimed difference. In the outstanding office action, columns 3 and 5 of Johnson are cited with respect to the claimed processor. Johnson states the following at column 3, lines 25-38:

> The methods use as a base for altitude the pressure altitude which is based on an altitude reading at a known first location, such as a departure runaway, and vertical changes in hydrostatic pressure using a hydrostatic pressure equation which is dependent on local pressure to calculate a corrected pressure altitude. A local temperature measurement can be used to further refine the corrected pressure altitude. The altitude based on the hydrostatic equation can be further supplemented with an altitude measurement from a secondary source, such as a global positioning unit or a radio altimeter. Preferably, the method uses a global positioning satellite (GPS) altitude to supplement the pressure altitude which is based on the hydrostatic equation.

In addition, Johnson states the following at column 5, lines 44-49:

> A second altitude, which is preferably an altitude determined from a global positioning satellite (GPS) system, is used in combination with the first altitude. Alternately, a radio altitude can be used in place of the global positioning altitude. More preferably, the radio altitude is used in conjunction with the global positioning altitude.

The above-cited sections of Johnson simply do not teach the calculation of a difference between barometric elevation readings and GPS elevation readings. After closely reviewing the complete teachings of Johnson, nowhere has it been found where the claimed difference calculation is performed.

Further, Johnson does not teach or suggest the claimed filter which filters the differences between the barometric and GPS elevation readings to produce a barometer correction quantity, where the filter is adjustable between a short-time constant and a long-time constant based on a time-lapsed since a predetermined event. The filter illustrated in Johnson in Figure 12 and described at columns 9 and 10 does not constitute the claimed filter. The complementary filter 135 within figure 12 recites the equation performed by the filter when calculating a GPS calibrated hydrostatic altitude. As is apparent from the complementary filter 135, the GPS calibrated hydrostatic altitude constitutes a summation of two components. The first component includes, among other things, the GPS altitude divided by a filter time constant, Tau, times a Laplace operator, s, summed with one. The second component of the GPS calibrated hydrostatic attitude, is a ratio between i, the product of the filter time constant, Tau, a Laplace operator, s, and the hydrostatic altitude, Hge and, ii, the filter time constant, Tau, and Laplace operator, s, plus one.

It is respectfully submitted that the filter operation performed in Figure 12 does not teach or support filtering a difference between barometric elevation readings and GPS elevation readings. Nor is the complementary filter 135 of Figure 12 in Johnson adjustable based on a time lapsed since predetermined event. Instead, the filter time constants of Johnson are set based on the GPS vertical figure of merit (VFOM) which is used as the current estimate of the accuracy of the GPS altitude. Johnson describes calculation of the filter time constants as follows at column 10, lines 9-13:

> The filter time constant, TAU or τ, is a function of the current GPS figure of merit. The lower the GPS VFOM, the lower the time

> constant. Therefore, the more accurate the GPS is, the more quickly the output follows the GPS altitude. When the accuracy of GPS degrades, the output more closely follows pressure altitudes. When the GPS figure of merit increases, the filter stops tracking.

From the foregoing, it is clear that the filter of Johnson is set based on the estimate of the accuracy of the GPS altitude. In contrast, not only does the claimed filter perform filtration of a difference calculated between barometric and GPS elevation readings, the claimed filter also adjusts between short and long time constants based on a time lapsed since a predetermined event, not based on the estimate of the accuracy of the GPS altitude. In view of the foregoing, it is respectfully submitted that claim 1 is neither anticipated, nor rendered obvious, by Johnson.

Turning to independent claim 11, Applicant respectfully traverses the obvious rejection thereof since it is believed, that no motivation exists to modify Johnson based upon the teachings of Tao. Simply stated, the Tao system is not analogous and neither Johnson, Tao, nor any other reference provides any motivation for modifying Johnson as maintained. Tao describes a method and apparatus for internal model control using a state variable feedback signal. Tao's system is not at all related to the determination of altitudes, the use of barometric measurements, or the use of GPS altitudes. Instead, in Tao's discussion of the Field of the Invention, Tao states the following:

> The present invention generally relates to the control of processes, such as papermaking processes, using internal mode control (IMC).

Tau is not at all concerned with the field of navigation devices, nor estimating altitudes based on barometric and GPS information.

In the outstanding office action, it is maintained that it would have been obvious to include the teachings of Tao's state feedback loop in Johnson's system "in order to perform dynamic calibration of process output signal, such as the measurements for a barometric sensor, wherein external transient disturbances are rapidly rejected even when the measuring process includes relatively long time delay." Applicant strongly disagrees that any such motivation exists or that the teachings regarding Tao's state feedback loop would be usable in a modification of Johnson's system in a manner that would render obvious to the claimed invention.

Claim 11 recites in a navigation device, a method for estimating altitude based on measurements from a barometric sensor and measurements from a GPS receiver. The method includes among other things, calculating a difference between first and second elevations based on barometric pressure measurements and GPS coordinate information. The claimed method further recites using a state feedback loop to drive the difference between the first and second elevations to zero and calculating an estimated altitude based on an output of the state feedback loop and the first elevation.

As explained above, Johnson's system does not calculate any such difference. Instead, Johnson's system utilizes a filter 135 that calculates a transfer function based upon filter time constants that are modified depending upon the current estimate of the accuracy of the GPS altitude. Johnson's filter 135 simply is not constructed, nor designed, to operate within or in connection with a state feedback loop that drives the difference between first and second

elevations to zero. The proposed modification based on Tao constitutes such a fundamental difference that Johnson's system would essentially need to be redesigned to operate in an entirely differently manner. No problem has been stated, or solution given, in the prior art that would motivate the person of ordinary skill to so fundamentally modify Johnson. Accordingly, claim 11 is believed to be patentably distinct over the prior art.

Turning to claim 18, a method is recited for estimating altitude based on GPS and barometric measurements. The method includes among other things, deriving a barometric altitude and a GPS altitude, correcting the barometric altitude based on a coarse calibration of the atmospheric pressure model to obtain a course estimated barometric altitude. After the course estimated altitude is obtained, the method further includes correcting the barometric altitude based on a difference between the course estimated barometric and GPS altitudes to obtain a fine estimated altitude. As explained above, Johnson does not teach or suggest any form of correction based on a difference between barometric and GPS altitudes. Hence, Claim 18 is believed to be patently distinct over the prior art.

Turning to the obviousness objection of claim 35, Applicant traverses this rejection as the secondary reference to Burgett does not qualify as prior art under 35 USC §103(c). The Burgett patent was filed April 12, 2001, while the subject application was filed June 25, 2002. Hence, Burgett only qualifies as prior art under 35 USC §102(e) (if at all). The inventors of the Burgett patent and of the present application were under a duty to assign both applications to the Garmin

and as such, the Burgett et al. patent does not qualify as prior art for use in an obviousness rejection.

In view of the foregoing, it is respectfully submitted that the pending claims define allowable subject matter. Should anything remain in order to replace the present application and condition for allowance, the examiner is kindly invited to contact the undersigned at the telephone number listed below. A favorable action on the merits is respectfully requested.

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APPENDIX

IN THE SPECIFICATION

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing summary, as well as the following detailed description of the preferred embodiments of the invention, will be better understood when read in conjunction with the appended drawings. For the purpose of illustrating the present invention, there is shown in the drawings, embodiments that are presently preferred. It should be understood, however, that the present invention is not limited to the precise arrangements and instrumentality shown in the attached drawings.

Fig. 1 illustrates a navigation device formed in accordance with at least one embodiment of the present invention.

Fig. 2 illustrates a block diagram of the internal components of a navigation device formed in accordance with an embodiment of the present invention.

Fig. 3 illustrates a graphical representation over time of a user elevation trajectory, and associated GPS elevation readings and barometric altimeter readings.

Fig. 4 illustrates ~~a flow chart setting forth~~ a processing sequence carried out in accordance with ~~an~~ at least one embodiment of the present invention.

Fig. 5 illustrates a flow chart setting forth a processing sequence carried out in accordance with an embodiment of the present invention.

IN THE CLAIMS

1. A navigation device comprising:

a barometric altimeter for obtaining barometric elevation readings based on barometric pressure measurements;

a processor for providing GPS elevation readings based on GPS measurements, said processor calculating differences between said barometric elevation readings and said GPS elevation readings;

a filter filtering said differences to produce a barometer correction quantity, said filter being adjustable between a short time constant and a long time constant based on a time lapsed since a predetermined event; and

said processor correcting said barometric elevation readings based on said barometer correction quantity.

2. The navigation device of claim 1, further comprising a calibration unit calibrating said barometric altimeter based on said barometric altitude correction quantity continuously while simultaneous providing navigation information.

Rule 1.126

3 ~~4~~. A navigation device comprising:

a barometric altimeter for obtaining barometric elevation readings based on barometric pressure measurements;

a processor for providing GPS elevation readings based on GPS measurements, said processor calculating differences between said barometric elevation readings and said GPS elevation readings;

a filter filtering said differences to produce a barometer correction quantity, said filter being adjustable between a short time constant and a long time constant;

said processor correcting said barometric elevation readings based on said barometer correction quality; and

~~3. The navigation device of claim 1, further comprising~~ a statistical model of barometric altimeter errors represented expected drift in the barometer elevation reading over a time lapsed since the device was last turned on, said filter adjusting filter characteristics between high and low gain based on said statistical model.

4. The navigation device of claim 1, wherein said filter performs the filtering operation based upon one of multiple sets of filter gain parameters, said processor setting said filter, when initially turned to one of said multiple sets of filter gain parameters based upon an elapsed time since said barometric altimeter was last calibrated.

5. The navigation device of claim 1, wherein said filter uses a first set of filter gain values to perform short-term averaging of said differences and a second set of filter gain values to perform long-term averaging of said differences.

6 ~~7~~. A navigation device comprising:

a barometric altimeter for obtaining barometric elevation readings based on barometric pressure measurements;

a processor for providing GPS elevation readings based on GPS measurements, said processor calculating differences between said barometric elevation readings and said GPS elevation readings;

a filter filtering said differences to produce a barometer correction quality, said filter being adjustable between a short time constant and a long time constant;

said processor correcting said barometric elevation readings based on said barometer correction quality; and

~~The navigation device of claim 1, further comprising~~ a statistical model of anticipated errors in said barometric elevation readings, said filter using low gain when said statistical model indicates that an anticipated error is small, said filter using high gain when said statistical model indicates that an anticipated error is large.

7. The navigation device of claim 1, wherein said processor and filter calibrate said barometric altimeter while the navigation device is in motion during which elevation changes.

8. The navigation device of claim 1, wherein said processor and filter continuously calculate said barometric altimeter correction quantity throughout operation while in a navigation mode.

9. The navigation device of claim 1, wherein said barometric altimeter calculates barometric elevation readings based on an atmosphere model correlating barometric pressure readings to particular elevations, said processor adjusting said atmosphere model continuously throughout operation based on said barometric altimeter correction quantity.

10. The navigation device of claim 1, further comprising an atmosphere model associating barometric pressure measurements to elevations, said processor adjusting said atmosphere model at least once during operation by recalculating said elevations associated with said barometric pressure measurements based on said differences between said barometric elevation readings and GPS elevation readings.

11. In a navigation device, a method for estimating altitude based on measurements from a barometric sensor and measurements from a GPS receiver, comprising:

obtaining a first elevation based on barometric pressure measurements;

obtaining a second elevation based on GPS coordinate information;

calculating a difference between said first and second elevations;

utilizing a state feedback loop to drive said difference between said first and second elevations to zero; and

calculating an estimated altitude based on an output of said state feedback loop and said first elevation.

12. The method of claim 11, further comprising:

computing at least two gain values defining a rate at which said state feedback loop converges to zero; and

using one of said at least two gain values in said state feedback loop.

13. The method of claim 11, further comprising selecting a gain value from a set of multiple gain values, said selected gain value controlling a rate at which said state feedback loop converges to zero.

14. The method of claim 11, wherein said state feedback loop continuously updates said altitude calculated based on said first elevation and said output of said state feedback.

15. The method of claim 11, wherein said state feedback loop updates, at discrete intervals non-continuously, said altitude calculated based on said first elevation and said output of said state feedback.

16. A method for estimating altitude based on GPS and barometer measurements, comprising:

upon start up, determining a time lapse since last calibration of barometric altitude;

obtaining from a barometer drift model, an expected error in barometer readings based on the time lapse since last calibration; and

obtaining an estimated altitude based on the expected error.

17. The method of claim 16, further comprising:

generating the barometer drift model based on a statistical analysis of barometric pressure data collected over a period of time at a known elevation.

18. A method for estimating altitude based on GPS and barometric measurements, comprising:

deriving a barometric ~~elevation~~altitude-from a barometer pressure measurement and an atmospheric pressure model;

deriving a GPS ~~elevation~~altitude from GPS information;

correcting said barometric ~~elevation~~altitude based on a coarse calibration of the atmospheric pressure model to obtain a coarse estimated barometric altitude; and

after obtaining the coarse ~~calibration~~estimated altitude, correcting the barometric altitude based on a difference between the ~~derived~~course estimated barometric and GPS ~~elevations~~altitudes to obtain a fine estimated ~~elevation~~altitude.

19. The method of claim 18, further comprising:

adjusting an initial base pressure of the atmospheric pressure model toward a standard pressure value based on an amount of uncertainty in the barometric ~~elevation~~altitude.

20. The method of claim 18, further comprising:

adjusting an initial base pressure of the atmospheric pressure model toward a standard pressure value based on an amount of uncertainty in the GPS ~~elevation~~altitude.

21. A method for correcting a barometer altitude reading of a navigation device, comprising:

deriving a barometer-based altitude;

calculating a GPS-based altitude;

determining an expected drift error representing an amount of drift anticipated in said barometer-based altitude based on a model of drift error;

calculating a correction quantity based on convergence of a baro-GPS relation between said barometer-based and GPS-based altitudes toward a steady state value;

adjusting a rate of said convergence toward said steady state value based on said expected drift error; and

correcting a barometer altitude reading based on said correction quantity.

22. The method of claim 21, further comprising:

determining an elapsed time since a last calibration operation, said calibration operation improving an accuracy of said barometer-derived altitude, said expected drift error being determined based on said elapsed time.

23. The method of claim 21, further comprising:

upon turning the device on, identifying an elapsed time since last calibration, wherein said determining step obtains expected drift error from said model of drift error based on said elapsed time.

24. The method of claim 21, further comprising:

creating a model of drift error based on a statistical analysis of pressure measurements taken over an extended period of time.

25. The method of claim 21, further comprising:

comparing said expected drift error to a threshold and setting said rate of convergence to one of fast and slow time constants based on said comparison.

26. The method of claim 21, further comprising:

comparing said expected drift error to a threshold; and

filtering said barometer-based and GPS-based altitudes based on one of fast and slow time constants.

27. The method of claim 21, further comprising:

filtering said baro-GPS relation between said barometer-based altitude and GPS-based altitude at one of high and low gain that is adjusted based on said expected drift error.

28. The method of claim 21, further comprising:

calibrating an atmospheric pressure model used to derive barometer-based altitude during said step of calculating said correction quantity.

29. The method of claim 21, further comprising:

coarsely filtering said baro-GPS relation when said expected drift error is above a predetermined threshold; and

finely filtering said baro-GPS relation when said expected drift error is below said predetermined threshold.

30. The method of claim 21, further comprising:

performing a steady state filter operation on a difference between said barometer-based and GPS-based altitudes based on one of high and low gain factors.

31. The method of claim 21, further comprising:

performing fast and slow convergence to calculate said correction quantity; and

switching between said fast and slow convergences based a relation between a vertical uncertainty of said GPS-based altitude and an amount of convergence of said baro-GPS relation.

32. The method of claim 21, further comprising:

filtering said baro-GPS relation; and

changing between high and low gain in said filtering step based on a degree to which said filtering step tracks said baro-GPS relation.

33. The method of claim 21, further comprising:

adjusting an initial model based pressure used to derive said barometer-based altitude between a standard base pressure and a measured base pressure.

34. The method of claim 21, further comprising:

adjusting an initial model base pressure relative to a standard base pressure as a function of an amount of uncertainty in said expected drift error.

35. A method for correcting a barometric altitude reading of a navigation device, comprising:

measuring barometric pressure;

calculating barometric altitude from an atmospheric pressure model and said barometric pressure;

re-calibrating said atmospheric pressure model by changing a model base pressure as a function of said barometric pressure and said barometric altitude; and

correcting said barometric altitude based on said re-calibrated atmospheric pressure model.

36. The method of claim 35, further comprising:

filtering noise from said barometric altitude in fine and coarse calibration operations, said re-calibrating step being performed at least once each time said fine calibration operation is performed.